ACALYPTRATE DIPTERA REARED FROM HIGHER FUNGI IN NORTHEASTERN OHIO[1]

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ABSTRACT: Living fungi were collected from two sites in northeastern Ohio between the fall of 1987 and fall of 1988. Flies reared from this material in the laboratory were determined to species.

Fourteen species of acalyptrate Diptera, comprising five families and eight genera, were reared from 44 species (14 families) of higher fungi. Among flies reared was *Leiomyza laevigata* [Asteiidae]. No descriptions of the immature stages of any of the over 100 species of Asteiidae worldwide are available. Also reared was *Drosophila guttifera* [Drosophilidae], another species whose biology is poorly known.

Most mycetophagous Diptera appeared to be generalists with respect to utilization of fungal species. Larvae of several species were probably scavengers, utilizing decaying fungal material.

Aside from a few publications (Buxton, 1960; Pielou, 1966; Pielou and Mathewman, 1966; Pielou and Verma, 1968; Shorrocks, 1973; Valley, *et al.*, 1969), the study of mycetophagous Diptera associated with mushrooms remains in a pioneer stage (Graves and Graves, 1985).

The purpose of this study was to determine the species of acalyptrate Diptera associated with higher fungi in northeastern Ohio (Portage Co.). Generalizations about the trophic relationships of certain Diptera to their fungal hosts (strict mycophagy, polyphagy, saprophagy) are also given.

MATERIALS AND METHODS

Two sites in Portage Co. were chosen for the collection of fungi: Towner's Woods near Kent and West Branch State Park near Ravenna.

Material was collected between September of 1987 and September of 1988. Each collected fungus was placed in a plastic bag or wrapped in wax paper to prevent larvae of one mushroom from entering another. Fungi were then identified using various sources (Graham, 1944; Lincoff, 1981). To avoid incidental occurrences of Diptera with the fungi (e.g. resting or hiding in crevices), only adults which actually emerged from larvae occurring within the fungus were counted.

Upon emergence, adult Diptera were retained alive for at least 24 hours to allow the exoskeleton to harden and then killed and preserved. Adults were either pinned or placed directly into 70% ethanol. Larvae

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were killed in boiling water and then preserved in 70% ethanol. Preserved specimens were placed in the Kent State University collection of Diptera.

Rearing required the construction of special containers which allowed the fungi to remain in a somewhat natural condition. The bottom of these rearing chambers consisted of the bottom of petri dishes (10 x 100mm) to which had been added moistened pulverized peat moss. It was necessary to keep the peat moss substrate in contact with the fungus initially and to moisten it frequently to prevent desiccation. As the fungus decayed, the substrate absorbed moisture produced by the fungus. The remainder of the rearing container consisted of clear plastic tubing having a diameter of 90mm and cut to various lengths. To the top of this was glued fine polyester mesh material. The rearing chamber was placed over the fungus in the petri dish. The fungal material was retained in the rearing containers for at least three months.

RESULTS AND DISCUSSION

Species of acalyptrate Diptera reared from the fungal material are given in table 1.

Table 1. Associations between acalyptrate Diptera species and their fungal hosts.

Acalyptrate Species	Fungal Host Species																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Asteiidae																				
Leiomyza laevigata		+																		
Chloropidae																				
Gaurax atripalpus							+													
Tricimba lineella				+																
Tricimba sp.											+									
Nartshukialla sp. poss. *melancholica*					+															
Drosophilidae																				
Drosophila duncani						+														
Drosophila falleni			+					+	+										+	+
Drosophila guttifera												+	+							
Drosophila putrida	+		+		+		+		+					+		+	+		+	+
Drosophila testacea																+				
Drosophila tripunctata						+														
Mycodrosophila dimidiata										+										
Ephydridae																				
Athryroglossa granulosa															+					
Lonchaeidae																				
unknown spp.																		+		

1 Agaricus arvensis *6 Laetiporus sulfureus* *11 Pholiota squarrosa* *16 Omphalotus olearius*
2 Lepiota rachodes *7 Polyporus pubescens* *12 Psilocybe polytrichophila* *17 Oudemansiella radicata*
3 Amanita muscaria *8 Russula compacta* *13 Collybia dryophila* *18 Pleurotus ostreatus*
4 Boletus chrysenteron *9 Russula vesca* *14 Marasmius oreades* *19 Pleurotus pulmonaria*
5 Pluteus cervinus *10 Pholiota mutabilis* *15 Mycena galericulata* *20 Tricholomopsis platyphyla*

Leiomyza laevigata Meigen [Asteiidae] has been reared from fungi previously (Buxton, 1960; Sabrosky, 1957). The family Asteiidae is a small one of some 100 species of which little is known. No descriptions of the immature stages of any species of Asteiidae are available.

Gaurax atripalpus Sabrosky [Chloropidae] has been reared previously from *Fomes* sp., [Polyporaceae] (Valley, *et al.*, 1969). It is apparent from this and our more recent rearings that *G. atripalpus* utilizes the fungi as both a food source and site of overwintering.

The rearing of *Athyroglossa granulosa* Cresson [Ephydridae] from fungi is surprising, because members of this family usually have larvae that are aquatic or semiaquatic. Grimaldi and Jaenike (1983) reared adults from larvae feeding in decaying skunk cabbage, *Symplocarpus foetidus* (L.) Nutt.

There are many known species of fungivorous Drosophilidae. *Drosophila falleni* Wheeler, *D. putrida* Sturtevant, *D. testacea* von Roser, *D. tripunctata* Loew, and *Mycodrosophila dimidiata* Loew, which were all reared in this study, are all well known fungal feeders (Jaenike, 1977, 1978; Jaenike, *et al.*, 1983; Patterson and Stone, 1952). However, none is known to be monophagous (Jaenike, 1978; Lacy, 1984). *Drosophila duncani* Sturtevant and *D. guttifera* Walker are also known to be fungal feeders but little is known about the life history of either species (Patterson and Stone, 1952).

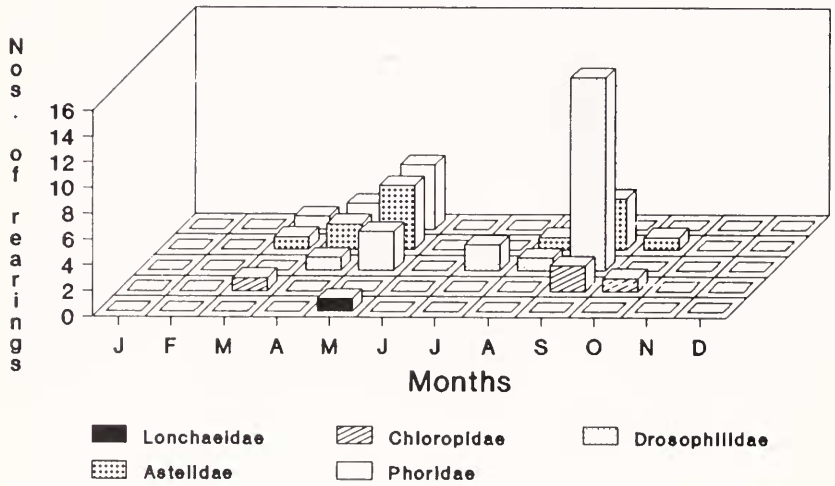
Two drosophilids, *D. falleni* and *D. putrida*, were reared from toxic species of *Amanita* mushrooms. These two as well as a few other species have been reared in the past (Jaenike, 1977; Jaenike, *et al.*, 1983) from mushrooms containing toxic amanitins. The amanitins are alkaloid compounds which are potent inhibitors of RNA polymerase II, the enzyme which transcribes genes that encode messenger RNA's (Wieland, 1968). Therefore, these compounds are potentially toxic to all eukaryotes. How these drosophilids manage to avoid being affected deleteriously is not known (Jaenike *et al.*, 1983).

An interesting question raised by this study concerns how so many different acalyptrate species, sometimes of the same genus, can coexist in the same substrate (Table 1)? As many as six species were found in the same fungal sporophore at the same time. When examined more closely it was apparent that in most cases larvae of the different species were feeding on the same material, at the same time, and in a similar manner (i.e. burrowing through the fungal sporophore). Apparently, competitive exclusion is not a factor here, as the fungal food probably was not a limiting resource. However, Grimaldi and Jaenike (1984), demonstrated that mycophagous larvae frequently do exhaust the food available in individual mushrooms. It is probable that predators or parasites of these lar-

vae functioned to reduce competition (both inter - and intraspecific) between larvae. Many parasitic wasps were obtained from many of the fungi surveyed.

Another point made evident by this study as well as earlier one (Buxton, 1960) is that certain fungi are more attractive to species of Diptera than other fungi. For example, *Pluteus cervinus* Fr. [Pluteaceae] possessed the greatest diversity of acalyptrate species (Table. 1). In contrast, several species of fungi were repeatedly examined, but no species of acalyptrate Diptera were obtained. The reasons for this are unclear and further research in this area is necessary. A final point to be made by this study concerns the mechanisms utilized by the many species of fungivorous Diptera to cope with the fact that fungal sporophores represent an ephemeral and unpredictable food source. The months of May and September produced the highest number of species of emerging adults (Fig. 1). Many species of Diptera probably initiate a reproductive diapause during times of no larval food sources, such as the dry summer months. Other species may utilize other food sources, including live, injured, and decaying vegetation. An example is *Drosophila guttifera* [Drosophilidae], a rare species that was believed to be strictly mycophagous (Patterson and Stone, 1952). However, we discovered that this species, at least in laboratory rearings, readily accepted other substrates (tomato juice, agar, bananas, commercial Drosophila medium) as an ovipositional site and larval food source (Bunyard and Foote, 1990). Similar results have been obtained in laboratory rearings of other mycetophagous species of the *guinaria* group of *Drosophila* (Grimaldi,

Fig. 1 Number of rearings per month for five families of acalyptrate Diptera.



pers. comm.). However, no field-based records of rearings from non-fungi sources have been reported for these species, and the laboratory results thus may not reflect reality.

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